WHAT IS CLAIMED IS:

1. A method for the formation of a fine resist hole pattern on a substrate surface in a photolithographic patterning process by using a halftone phase-shift photomask, which comprises the steps of:

(1) forming a photoresist layer on the substrate surface by using a positive-working photoresist composition comprising (A) 100 parts by weight of a resinous compound capable of being imparted with increased solubility in an aqueous alkaline solution by interacting with an acid, (B) from 1 to 20 parts by weight of a compound capable of generating an acid by irradiation with a radiation, (C) from 0.1 to 25 parts by weight of a compound having, in a molecule, at least two vinyloxy groups which react with the component (A) to form crosslinks, and (D) from 0.01 to 1 part by weight of an organic amine compound;

(2) patternwise exposing the photoresist layer to light through a halftone phase-shift photomask;

(3) developing the photoresist layer to form a patterned resist layer; and

(4) subjecting the patterned resist layer to a heat treatment to cause reduction of the resist pattern size by thermal flow.

2. The method as claimed in claim 1 in which the heat treatment in step (4) is conducted at a temperature in the range from 110 to 180 °C for 30 to 180 seconds.

3. The method as claimed in claim 1 in which the component (C) is a polyhydric alcohol substituted by vinyloxy groups for the hydrogen atoms of at least two hydroxyl groups in a molecule.

4. The method as claimed in claim 3 in which the component (C) is cyclohexanedimethanol divinyl ether.

5. A positive-working photoresist composition which comprises, as a uniform solution in an organic solvent;
(A) 100 parts by weight of a resinous compound capable of being imparted with increased solubility in an aqueous alkaline solution by interacting with an acid;
(B) from 1 to 20 parts by weight of a compound capable of generating an acid by irradiation with a radiation;
(C) from 0.1 to 25 parts by weight of a compound having, in a molecule, at least two vinyloxy groups which react with the component (A) to form crosslinks; and
(D) from 0.01 to 1 part by weight of an organic amine compound.

6. The composition as claimed in claim 5 in which the component (A) is a polyhydroxystyrene resin having a weight-average molecular weight in the range from 2000 to 30000 with a molecular weight dispersion not exceeding 6.0, of which from 10 to 60% of the hydroxyl hydrogen atoms are substituted by acid-dissociable groups selected from the group consisting of *tert*-butyloxycarbonyl, *tert*-butyloxycarbonylmethyl, *tert*-butyl, tetrahydropyranyl, tetrahydrofuranyl, 1-ethoxyethyl and 1-methoxypropyl groups.

7. The composition as claimed in claim 5 in which the component (A) is a combination of (a1) a hydroxystyrene-based copolymer containing, as a part of the monomeric units, 10 to 60% by moles of *tert*-butyloxycarbonyloxystyrene units and having a weight-average molecular weight of 2000 to 30000 with a molecular weight dispersion not exceeding 6.0 and (a2) a hydroxystyrene-based copolymer containing, as a part of the monomeric units, 10 to 60% by moles of alkoxyalkyloxystyrene units and having a weight-average molecular weight of 2000 to 30000 with a molecular weight dispersion not exceeding 6.0 in a weight proportion in the range from 90:10 to 10:90.

8. The composition as claimed in claim 5 in which the component (A) is a combination of (a3) a hydroxystyrene-based copolymer containing, as a part of the monomeric units, 10 to

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60% by moles of tetrahydropyranyloxystyrene units and having a weight-average molecular weight of 2000 to 30000 with a molecular weight dispersion not exceeding 6.0 and (a2) a hydroxystyrene-based copolymer containing, as a part of the monomeric units, 10 to 60% by moles of alkoxyalkyloxystyrene units and having a weight-average molecular weight of 2000 to 30000 with a molecular weight dispersion not exceeding 6.0 in a weight proportion in the range from 90:10 to 10:90.

9. The composition as claimed in claim 5 in which the component (A) is a combination of (a4) a hydroxystyrene-based copolymer containing, as a part of the monomeric units, 10 to 60% by moles of *tert*-butyloxystyrene units and having a weight-average molecular weight of 2000 to 30000 with a molecular weight dispersion not exceeding 6.0 and (a2) a hydroxystyrene-based copolymer containing, as a part of the monomeric units, 10 to 60% by moles of alkoxyalkyloxystyrene units and having a weight-average molecular weight of 2000 to 30000 with a molecular weight dispersion not exceeding 6.0 in a weight proportion in the range from 90:10 to 10:90.

10. The composition as claimed in claim 5 in which the component (A) is a copolymer consisting of hydroxystyrene units and acrylic or methacrylic acid units, of which the carboxyl hydrogen atoms in the acrylic or methacrylic acid units are substituted by acid-dissociable groups selected from the group consisting of *tert*-alkyl groups, 1-alkylcyclohexyl groups, 2-alkylcyclohexyl groups and 2-alkyl polycycloalkyl groups.

11. The composition as claimed in claim 5 in which the component (A) is a copolymer having a weight-average molecular weight in the range from 2000 to 30000 with a molecular weight dispersion not exceeding 6.0 and consisting of 40 to 80% by moles of hydroxystyrene units, 10 to 40% by moles of styrene units and 2 to 30% by moles of acrylic or methacrylic acid units substituted for the carboxyl hydrogen atoms by acid-dissociable groups.

12. The composition as claimed in claim 5 in which the component (C) is a compound selected from the group consisting of polyhydric alcohols substituted by at least two vinyloxy groups in a molecule.

13. The composition as claimed in claim 12 in which the component (C) is a divinyl ether of an alkyleneglycol having an alicyclic ring structure in the molecule.

14. The composition as claimed in claim 13 in which the component (C) is cyclohexanedimethanol divinyl ether.

15. The composition as claimed in claim 5 in which the component (D) is an amine compound selected from the group consisting of secondary aliphatic amines and tertiary aliphatic amines.

16. The composition as claimed in claim 15 in which the component (D) is selected from the group consisting of dimethylamine, trimethylamine, diethylamine, triethylamine, tri-n-propylamine, triisopropylamine, tri-n-butylamine, triisobutylamine, tri-*tert*-butylamine, tripentylamine, diethanolamine, triethanolamine and tributanolamine.

17. The composition as claimed in claim 16 in which the component (D) is diethanolamine, triethanolamine or tributanolamine.

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